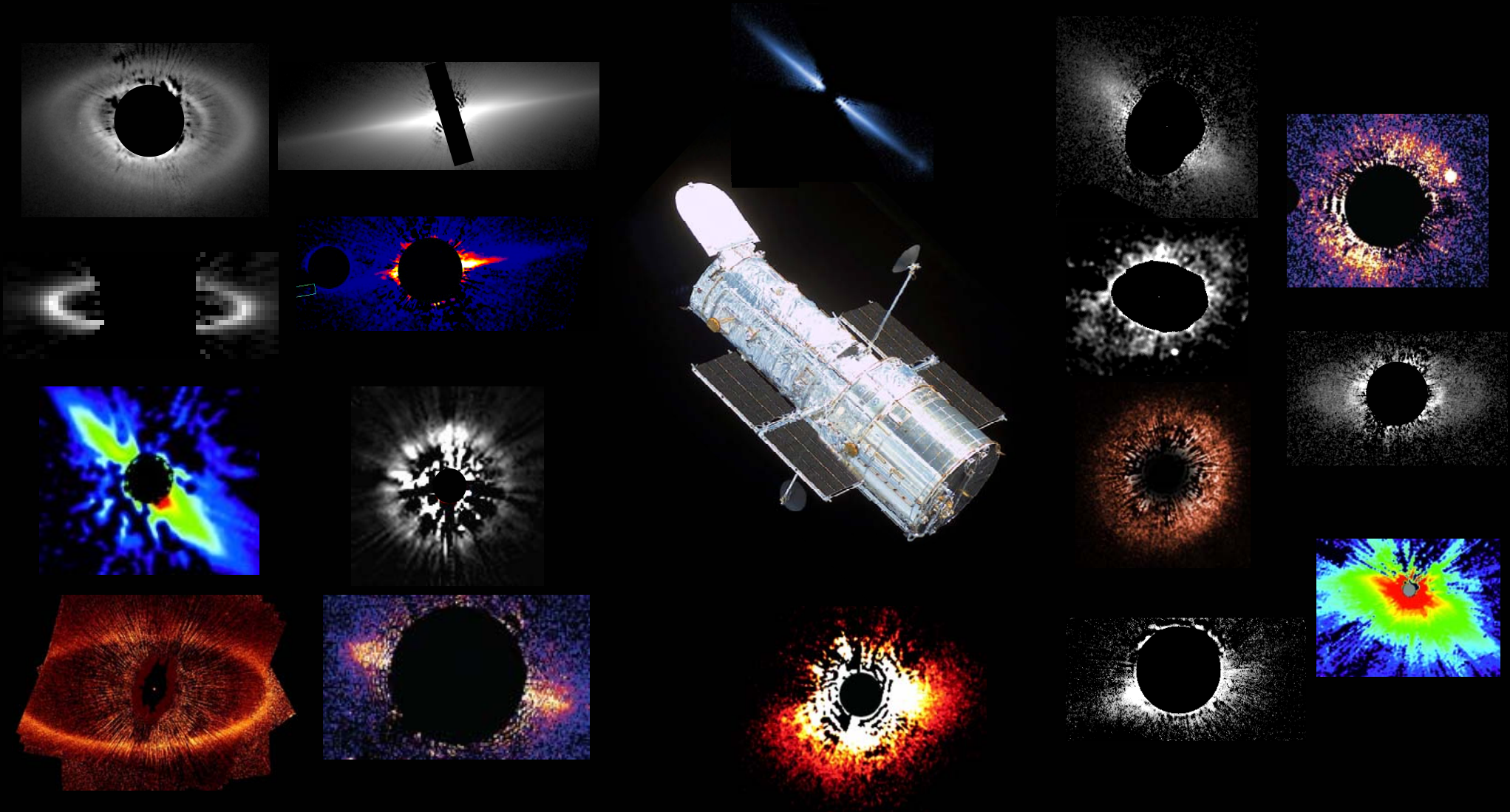


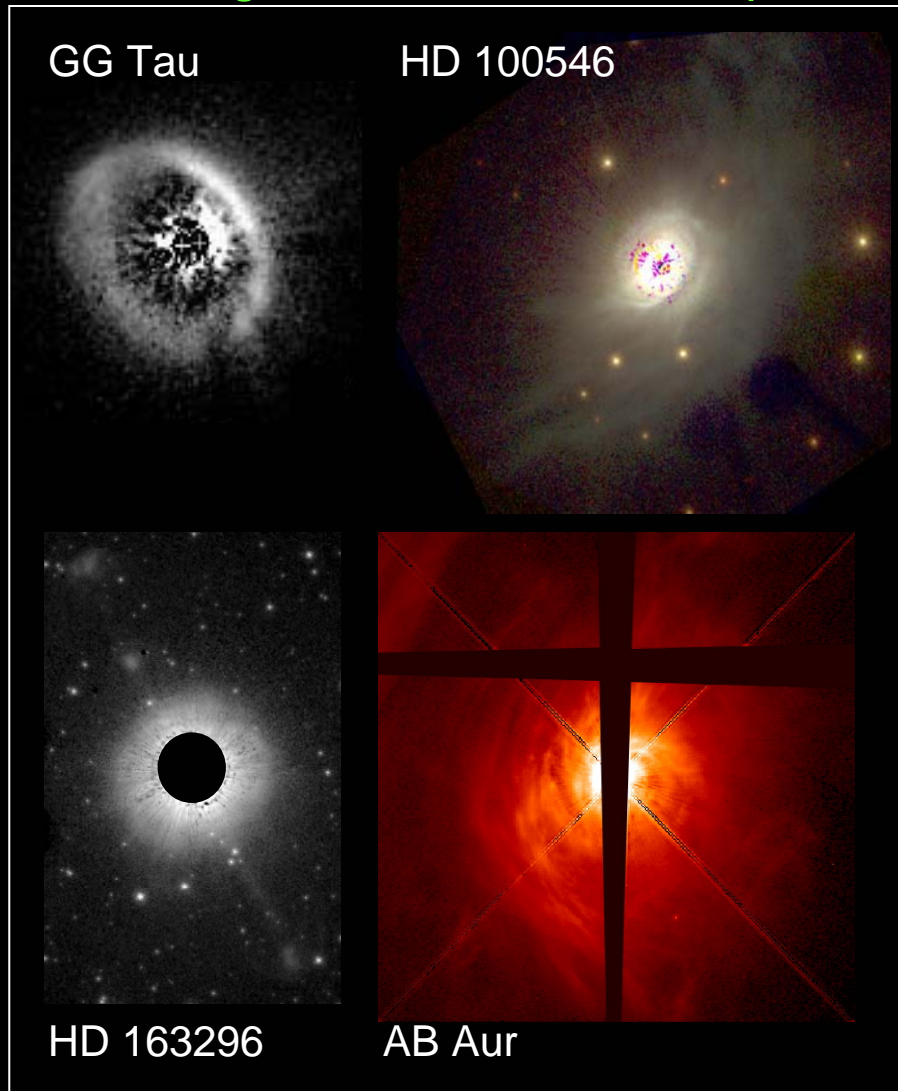
HST Imaging of Debris Disks

*John Krist, K. Stapelfeldt, G. Bryden, C. Beichman (JPL)
D. Golimowski (JHU/STScI), D. Ardila (IPAC),
M. Clampin (NASA/GSFC), C. Chen (NOAO/STScI)*



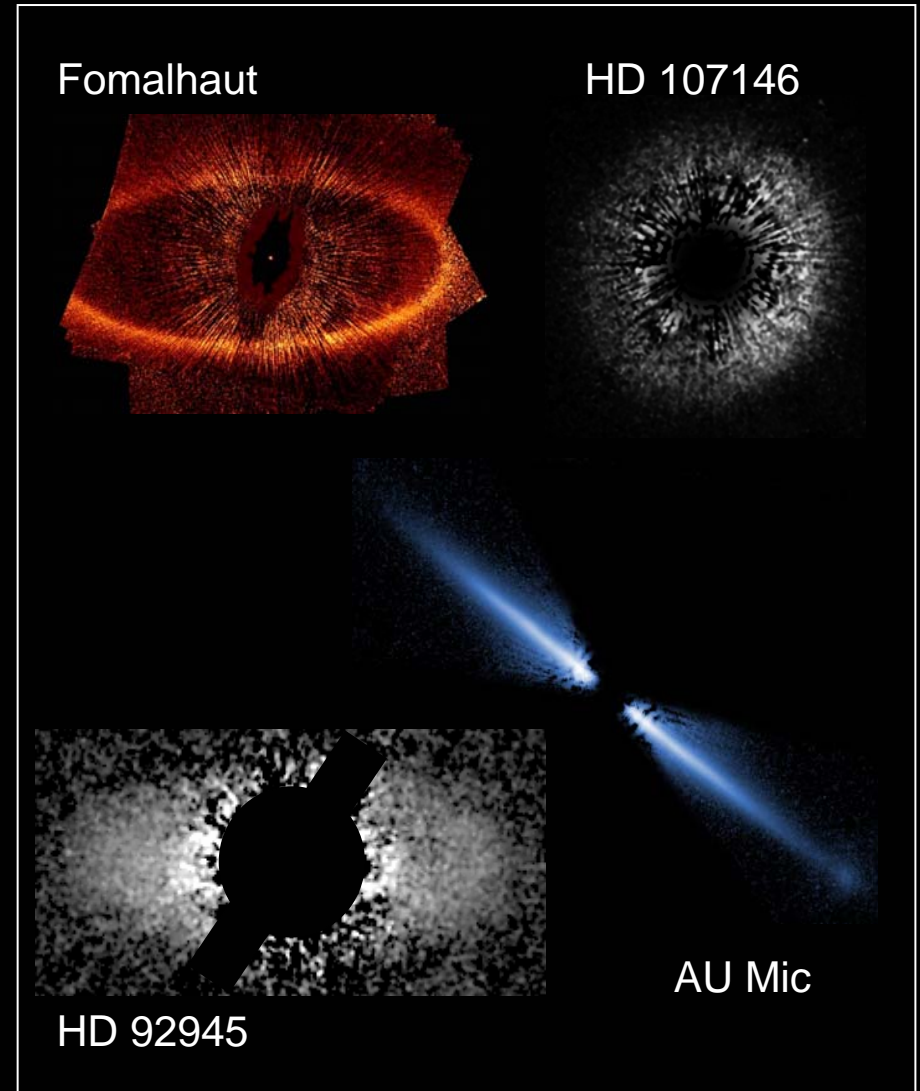
Young Star Disks vs. Debris Disks

Young Star Disks & Envelopes



$< \sim 10$ Myr, $> M_{Jup}$, Optically thick,
Gas rich, Accreting

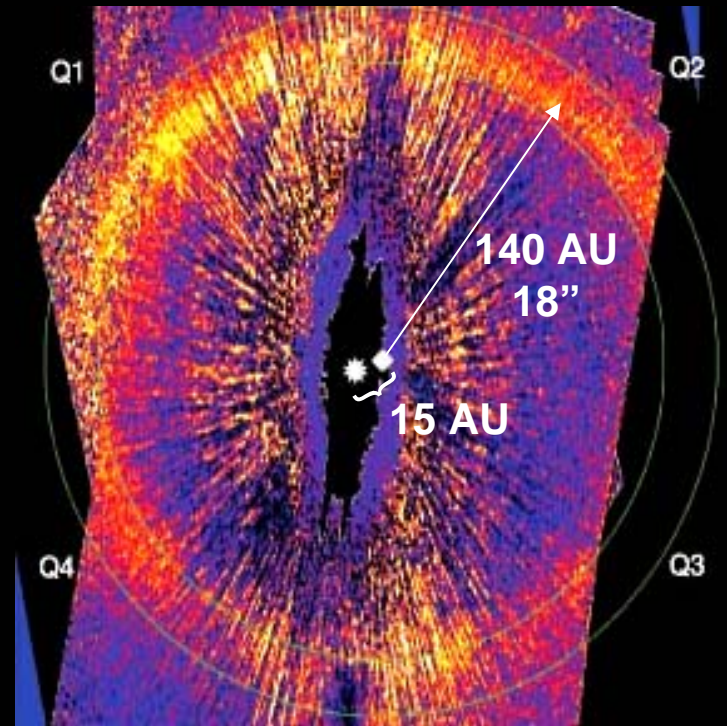
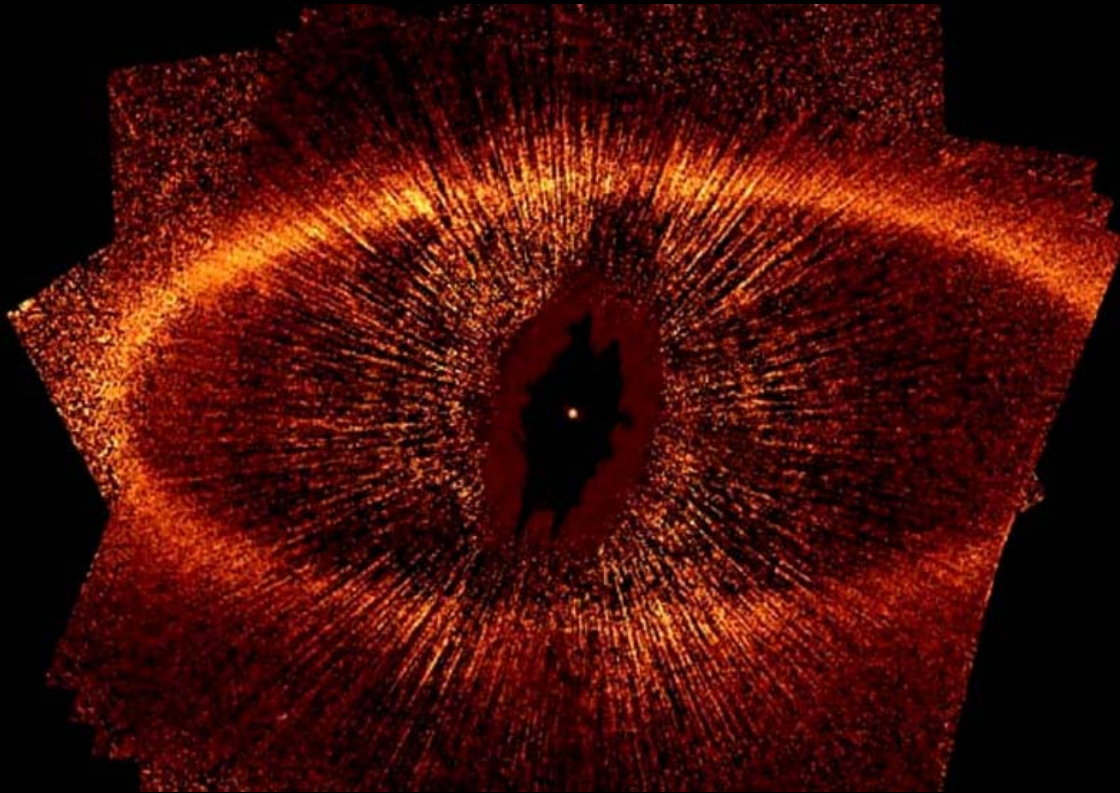
Debris Disks



$> \sim 10$ Myr, $< \sim M_{Earth}$, Optically thin,
Gas poor, Collisional debris

Signs of Planets: The Disk of Fomalhaut

HST/ACS (Wide V band)



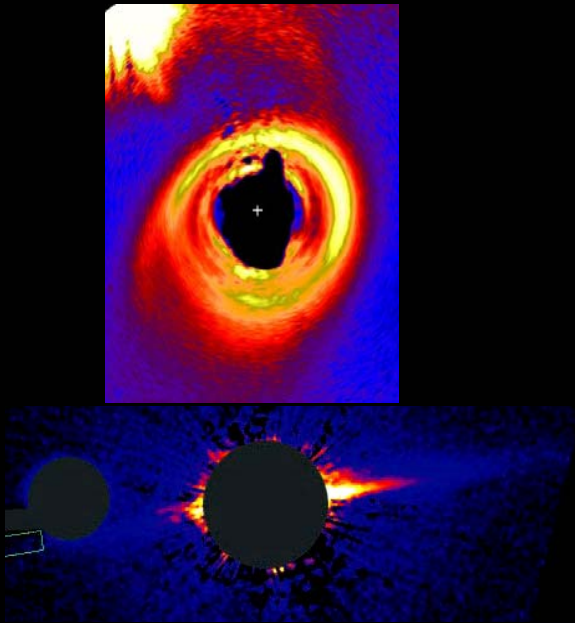
Deprojected

Kalas, Graham, & Clampin (2005)

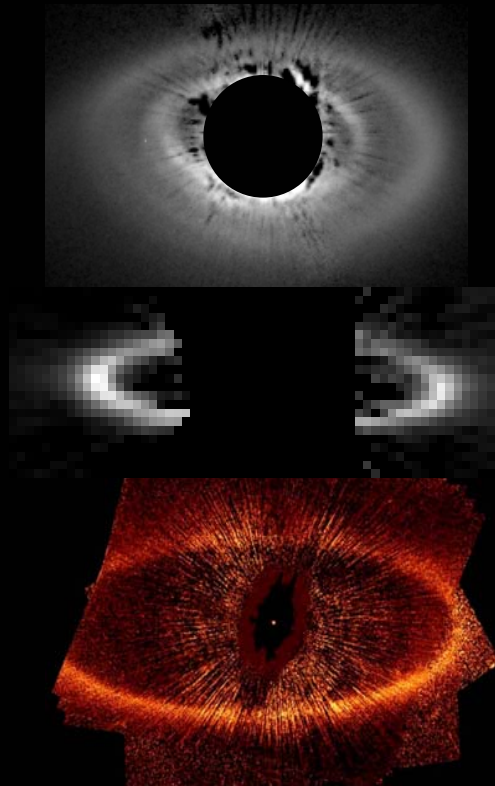
Quillen (2006) suggests a Neptune-Saturn mass planet at $r = 119$ AU

Signs of Stellar & Planetary Encounters?

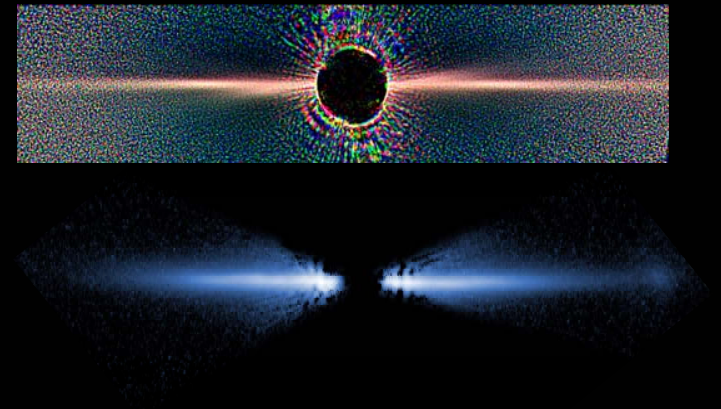
Stellar
Encounters



Clearings,
Rings



Secondary disks,
Warps



HST Images (various authors)

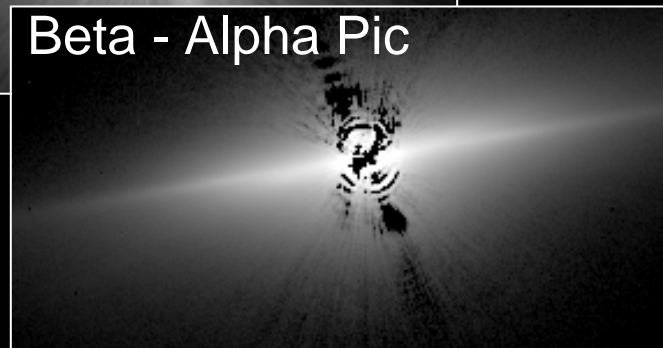
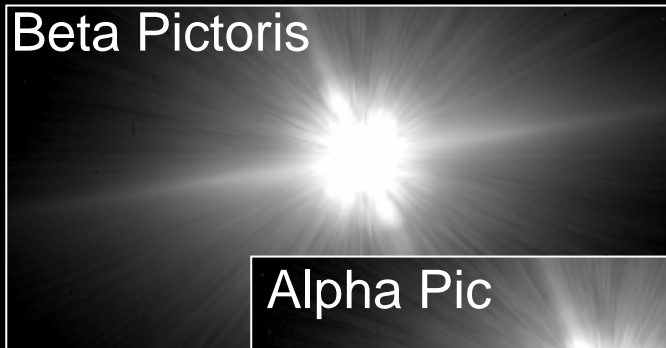
Program Description

- Use HST to image debris disks and characterize their structure
- Candidate disks were identified by *Spitzer* infrared excess measurements
- Visible-light imaging with *Hubble* using the ACS camera's coronagraph
- Collaboration including *HST*/ACS and *Spitzer*/MIPS science team members

Observing Debris Disks with *HST*

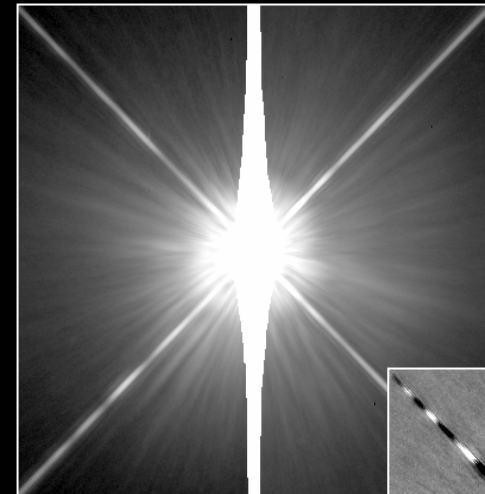
The stability of HST allows diffracted and scattered light to be subtracted

Reference PSF Subtraction

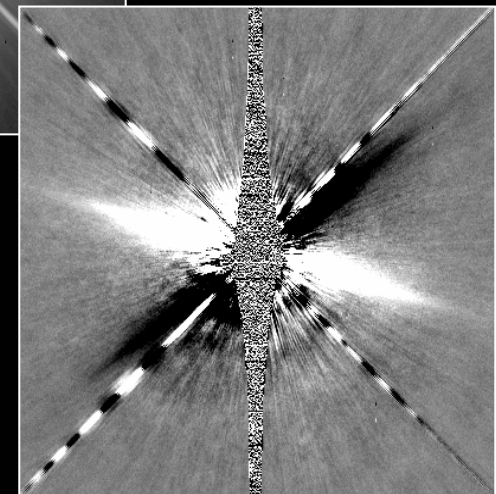


ACS coronagraph
Golimowski et al. (2006)

Roll Subtraction



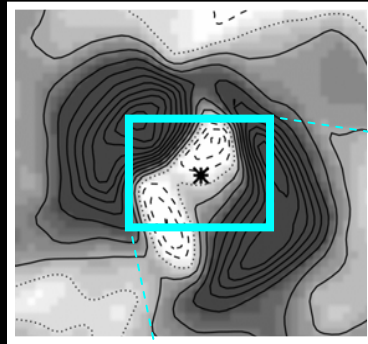
Beta Pic
WFPC2
WFPC2 Science Team



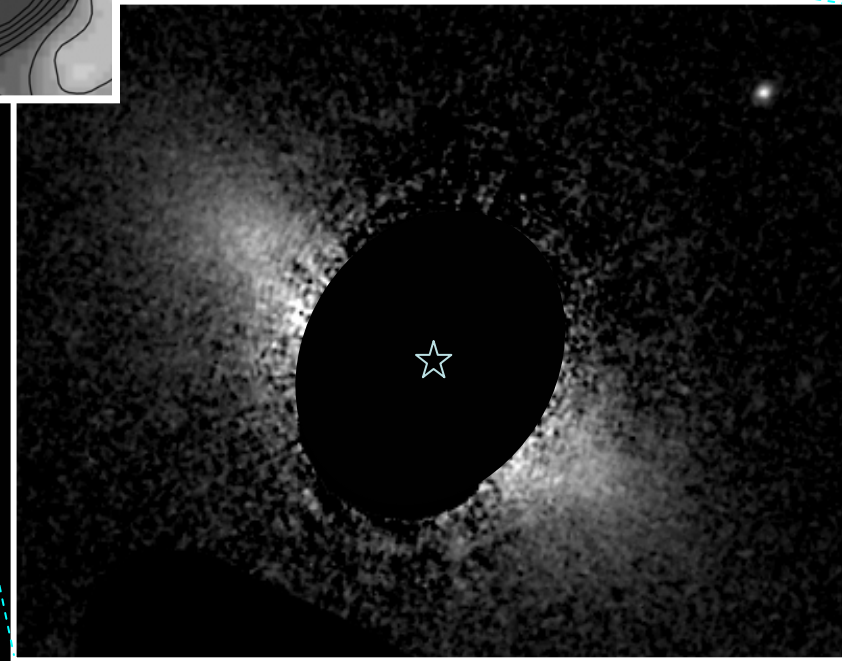
HD 10647(HR 506)

F9V, 17 pc, 0.3-7 Gyr, $L_d/L_=3 \times 10^{-4}$*

Spitzer/MIPS 70 μm
Bryden et al. (in prep)



HST/ACS (Wide V band)
Stapelfeldt et al. (in prep)



350 AU (20'')

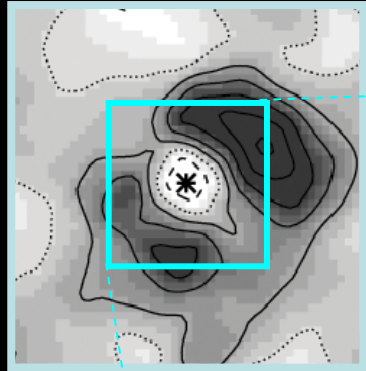
Has R-V planet: $a = 2 \text{ AU}$, $M \sin i = 0.91 M_{\text{Jup}}$

Stapelfeldt et al. (in prep)

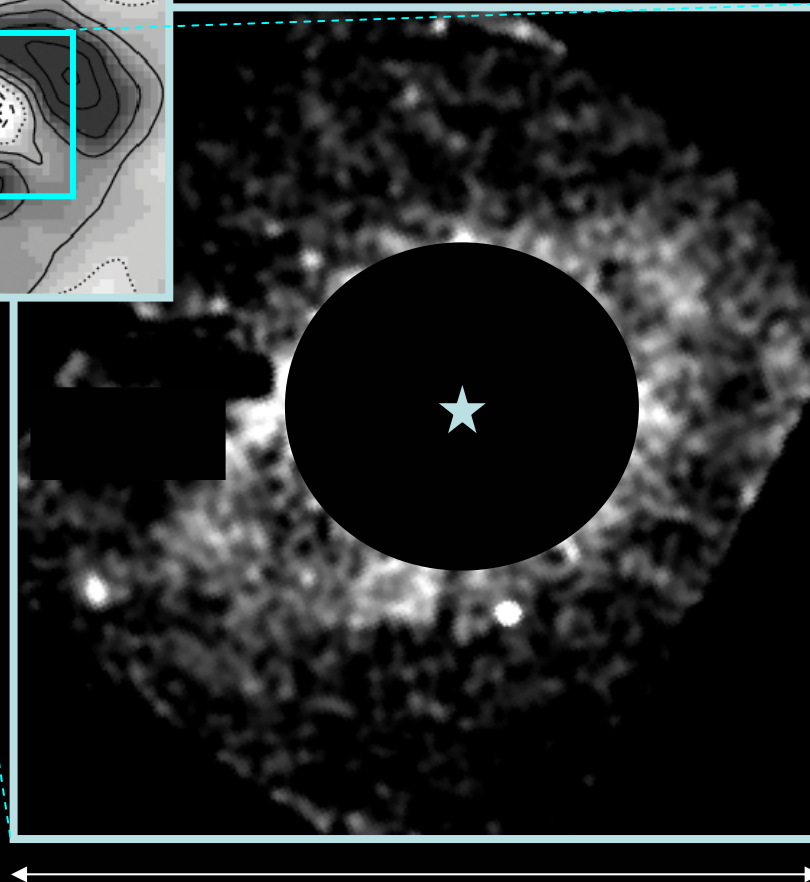
HD 207129

G0V, 16 pc, ~6 Gyr, $L_d/L_* = 1 \times 10^{-4}$

Spitzer/MIPS 70 μm
Bryden et al. (in prep)



HST/ACS (Wide V band)
Krist et al. (in prep)



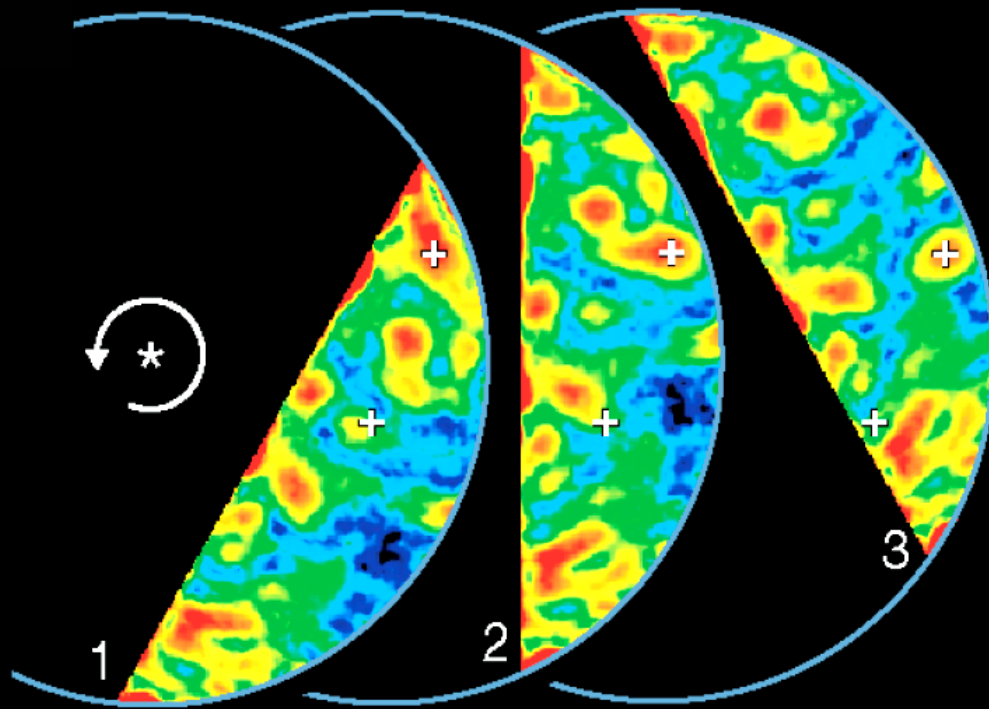
Smoothed,
4x4 Binned

470 AU (30")

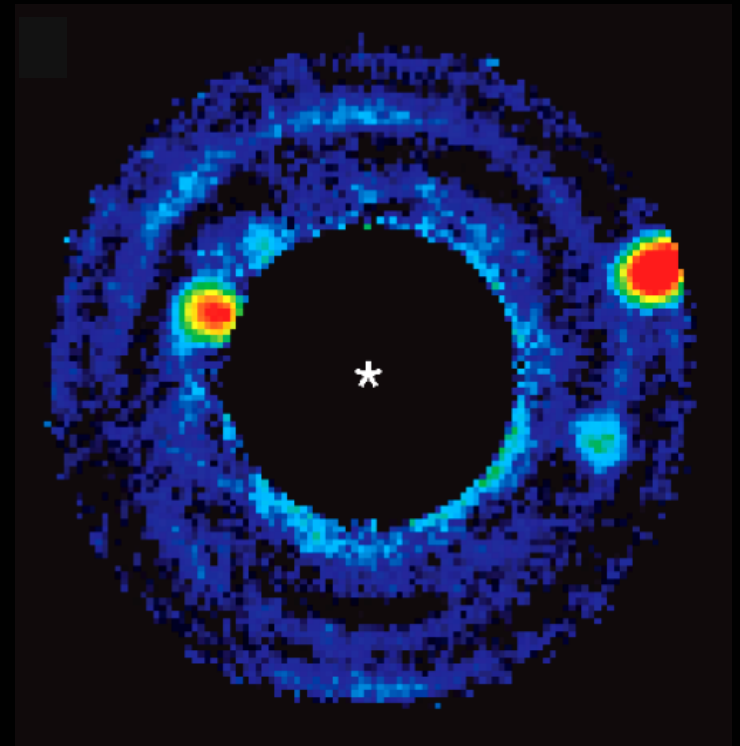
- Seen only in roll subtractions
- Faintest disk yet seen
 $V = 24 \text{ mag / arcsec}^2$

Applying HST Image Processing Techniques to JPL HCIT Data

Real HCIT Images with Implaneted
Simulated Planets



After Roll Combination



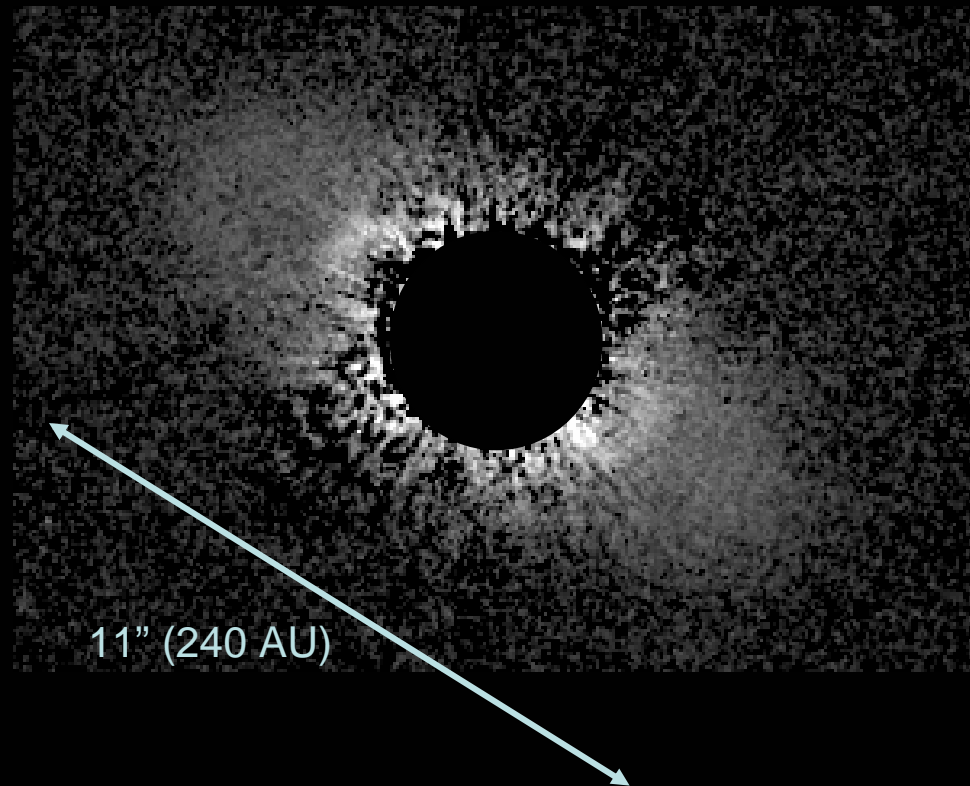
The HCIT data was processed using the same software that extracted the HD 207129 disk image

See Trauger & Traub, *Nature*, 446, 771 (2007)

HD 92945

K1V, 22 pc, ~100 Myr, $L_d/L_=8 \times 10^{-4}$*

ACS (Wide V band)



11" (240 AU)

Golimowski et al. (in prep)

Conclusions

- Large central clearings in debris disks are common
 - Signs of tidal clearing by unseen planets?
- Debris disks have similar structures regardless of stellar type
- Techniques and experience gained from HST coronagraphy can be applied to future missions (e.g. TPF, Eclipse, etc)